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## **CHINA IMPORTS TECHNOLOGY: POLICY AND PERFORMANCE**

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**March 1986**

*Author: Donald R. DeGlopper*

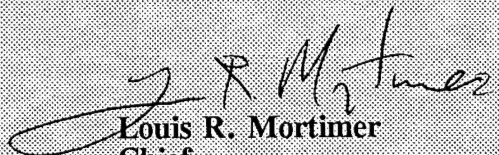
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## PREFACE

This study explores options open to Chinese leaders in their efforts to manage the process of technology transfer. It is intended to demonstrate the consequences for technology transfer of various policy choices, as well as the way the effort to successfully assimilate foreign technology generates pressures for changes in China's administrative structures and economic and foreign policies. It sets out a range of policy options and suggests likely domestic advocates of each. The implications of the drive for technology transfer for China's domestic economic policy and foreign trade are discussed.

Open-source materials including studies of technology transfer and of Chinese economics and politics, as well as US and Chinese press accounts, and a range of international business and trade publications were used. Information in this study is current as of 15 June 1985.

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## SUMMARY

The economic and foreign trade policies adopted by China since 1980 have promoted technology transfer. Because policies affecting technology transfer are inextricably linked with general economic and foreign-trade policy, overall policy is made at the highest political level by a State Council "special working group on science and technology" headed by Premier Zhao Ziyang. The scope and diversity of technology necessary to upgrade existing facilities has overwhelmed the cumbersome central planning and import-licensing system, which has become a serious impediment to the effective transfer of technology. Problems with the centralized system have generated pressure for economic decentralization and devolution of decision-making.

The need to implement effective policies for importing and assimilating advanced foreign technology if China is to achieve its goal of general modernization has thus been a major force for economic reform. Pressure for reform and decentralization will increase along with increases in the flow of foreign technology and in close and enduring relations with foreign corporations.

Although there is general consensus on the importance of technology transfer, the various sectors of Chinese industry and national and local governments have different goals and interests in technology import. Further elaborations and modifications of the overall technology import policy are liable to reflect disputes or contests between such bureaucratic/industrial interest groups. As the volume of imports grows, technology transfer is fast becoming an accepted part of China's economy, and as such will increasingly be subsumed into the normal, on-going processes of Chinese politics and policy modification.

## 1. INTRODUCTION

### a. The Need for Foreign Technology

China's current goals of modernization and rapid economic growth depend on the large scale introduction of foreign technology. Because this has been recognized by the country's leaders, laws and regulations have been made to facilitate the acquisition of technology. In a characteristic statement, Premier Zhao Ziyang in December 1983 described importing advanced technology as "a major policy of the state," and "a fundamental principle necessitated by the country's determination to seek technical progress as quickly as possible."<sup>1</sup> The October 1984 Decision of the Central Committee of the Communist Party of China on Reform of the Economic Structure stated that:

national seclusion cannot lead to modernization. Since the 3rd Plenary Session of the 11th Central Committee (December 1978), we have undertaken opening to the outside world to be our long-term, basic state policy, a strategic measure for accelerating socialist modernization.<sup>2</sup>

As China's statistical services have been rehabilitated since the Cultural Revolution, the very high costs of the industrial policies of the 1950s-1970s have become evident. The heavy industrial sector, which had been consistently favored over agriculture and light industry, has shown low productivity and a high degree of waste, duplication, and misallocation. As China has opened to the outside world, the extent of the gap between Chinese and world standards has become increasingly evident. For example, one article pointed out that even in bicycle design and production, China lags far behind, asking "Why have China's bicycles been the same design for decades and why have their cost and quality fallen so far behind the level of the developed countries?"<sup>3</sup> The problems are now widely recognized and discussed, and the current leadership has clearly made efficiency and technical improvement (rather than social equality, ideological transformation, or even gross output) a top priority. China aims to import technology and know-how rather than finished products and to concentrate on renovating existing facilities rather than adding complete new plants. Achieving the goal of quadrupling production by 2000 is estimated to depend 50 percent on the progress of science and technology.<sup>4</sup>

The task is to import appropriate technology to renovate and upgrade several thousand factories, whose equipment dates back to the 1930s. This is an unprecedented problem because China's previous experience with technology transfer, the massive Soviet technical aid program of the 1950s, featured large projects which brought in complete plants. Much of the technology to be imported is production or process technology, representing either better or more efficient ways to produce things China already produces, such as basic chemicals, or improved models of such items as truck transmissions or telephone cables. Such technology is usually the proprietary knowledge of foreign corporations, with which China has demonstrated an unprecedented willingness to cooperate. With the explicit goal of promoting technology transfer, China has made great efforts to attract foreign business and foreign capital and has even permitted foreign-owned subsidiaries to operate in China.



## b. The Need for a Technology Transfer Policy

All these decisions, made for the most part since 1978, are necessary prerequisites for an effective technology transfer program. But they do not in themselves constitute a complete policy. "Technology transfer" is a short-hand term for a complex, interactive process. The recipient of a technology transfer is not passive, but must play an active part, making many decisions at each stage of the process and often changing major features of the context into which the new technology is inserted. The successful assimilation of technology is by no means assured, and the chances of mistakes and wasted resources are high. For optimal results, a definite policy and careful management are necessary. Chinese managers at every level from the central government down to the factory floor must make choices and attempt to coordinate their efforts.

Technology acquisition may be considered from several perspectives, each highlighting a link with a different economic and administrative sector. Technology may be considered as a valuable resource to be allocated to favored industries and localities, and as such is a central element in both central planning and internal bureaucratic politics. It is a commodity purchased with scarce foreign exchange, which means that it impinges on issues of foreign trade and foreign relations. The question of what administrative body or level decides what technology to import or controls the necessary foreign exchange is a central issue in the ongoing debates and policy shifts on centralization and decentralization. The effective assimilation of technology often demands shifts in factory organization or management and serves to highlight macroeconomic problems (as in the Hebei electronics components factory, where the imported machine stood idle 10 months of the year because the necessary raw materials for increased production had not been allocated by the central planners and no provision had been made within the plan to use the extra output). Chinese discussions of importing technology often conclude with discussions of industrial reform and problems with the price system.

## 2. POLICY-MAKING BODIES AND PROCESSES

### a. Overall Policy

Because technology transfer is central to China's modernization plans and is closely related to other economic and administrative issues, it is impossible to separate technology transfer from those issues and deal with it as a single issue. A technology transfer policy is necessarily part of a more comprehensive policy, which ensures that overall technology transfer policy is made at the highest political level, that is, by the Chinese Communist Party Central Committee and the State Council. Leaders such as Deng Xiaoping and Zhao Ziyang are quite concerned with importing technology, as manifested both in their frequent public statements and in the passage of a series of laws and administrative regulations which are explicitly intended to facilitate technology transfer. Recent examples are the Patent Law, promulgated in March 1984; the March 1985 Law on Sino-Foreign Economic Contracts; and the May 1985 State Council Regulations on Technology Imports.<sup>5</sup>

Further definition of overall policy directions is provided by public statements of various leaders and administrators, repetitive editorials in



authoritative newspapers and journals, administrative regulations, decrees and decisions. The message conveyed in these ways is that, in general, China seeks technology rather than pure commodities and that foreign suppliers will be selected for their willingness to provide technology and training. Recent contracts for such major imports as electric locomotives, civil airliners, and minicomputers have all included technology transfer provisions. Press commentary makes it clear that these are considered exemplary deals.<sup>6</sup> Imported technology and key equipment may be exempted from customs duty, and projects using such technology and equipment may be exempted from certain industrial and commercial taxes, as well as receiving preferential allocation of funds, foreign exchange, or credit.<sup>7</sup>

Since 1978 the general trend has been toward increasing decentralization and devolution of decisionmaking to lower levels. The basic reason for this has been recognition of the inability of the former, tightly centralized foreign trade system to handle the increased volume and diversity of imports which the widespread upgrading of existing facilities demands. The system now evolving is, on the whole, moving toward greater functional specialization, with the former state trading monopolies becoming general import-export agencies, and with many specialized trading, consulting, and financing bodies growing up.<sup>8</sup>

Decentralization and devolution, however, are relative terms, and apply to an economy dominated by the state and its various ministries and commissions. Decentralization has often meant a shift in the locus of decisionmaking and approval from Beijing to provincial capitals or to such major cities as Shanghai or Tianjin. It is taken for granted that importing technology will be done under official supervision in a context of planning, permits, and regulation. Thus, the May 1985 State Council Regulations on Technology Imports state that all contracts between Chinese enterprises and foreign suppliers must be submitted to the Ministry of Foreign Economic Relations and Trade or to other unspecified "examination and approval organs."<sup>9</sup>

#### b. Controls on Imports

The reasons for administrative monitoring and controls on imports are clear. Scarce foreign exchange must be used for the most beneficial projects; China should not import products which it can produce itself; duplication should be avoided; and better financial terms are likely if negotiations with foreign suppliers are conducted by experienced specialists. Furthermore, it is likely that there are many Chinese officials for whom management and planning are ends in themselves.<sup>10</sup> The consequence is that in practice the effort to control imports has produced a bureaucratic process of baffling complexity and frequent delay which has become a major impediment to the transfer of technology. Before the 1984 delegation of some import approval authority to the municipalities of Shanghai and Tianjin, the Tianjin Municipal Printing Industry had to wait 2 years for approval of an \$180,000 import project, partially because applications for imports had to be stamped by 39 different offices before they could be approved. After devolution, applications needed to be stamped only five times and approval and bank financing for a \$480,000 plant was secured in only 3 days.<sup>11</sup> In late 1984, a major Chinese oilfield and an American manufacturer of drilling equipment agreed on a sale of US equipment and transfer of technology, only to have the deal collapse

when the Ministry of Petroleum unexpectedly withheld its approval. Its ostensible reason was that China already manufactured drilling equipment, although both the oilfield officials and their foreign partner considered the Chinese equipment outmoded and incapable of performing the task for which the US equipment was to have been imported.<sup>12</sup> While the logic of controlling imports of technology is clear, implementation suffers from bureaucratic confusion, overlapping authority, and unclear procedures, none of which have been helped by frequent reforms, changes, reversals of reforms, and general oscillation between centralization and decentralization.

c. The State Plan and Centralized Purchases

It is not clear how specific Chinese enterprises select technology to import or are selected to receive technology some other body has decided to import. As decisionmaking and purchasing authority devolves to lower administrative levels (and as far as end-users in some exceptional cases), the picture becomes even more confusing. A basic distinction is made between items included in the State Economic Plan and those outside the plan. As the head of a recently formed Chinese trading corporation put it:

"China has a planned economy. Each year's imports and exports are planned in advance, and it is much more difficult to buy or sell products that fall outside the plan."

And, to add to the difficulties of foreign would-be suppliers, he continues:

"The Chinese often consider the purchase plan a commercial secret, and do not wish to reveal it. Sometimes even the Chinese trading corporations lack details of the plan."<sup>13</sup>

On the other hand, Chinese authorities have frequently published lists of enterprises seeking foreign technology, cooperation, or investment, and invited negotiations.<sup>14</sup> Some regional authorities or enterprises, particularly in Guangdong and coastal regions, have been permitted to retain foreign exchange they have earned and to import goods, including technology, outside the plan. There is, in addition, a thriving gray market for such items as minicomputers or electronic components which are brought in from Hong Kong.<sup>15</sup>

At the highest level and in the most general terms the State Economic Plan, which includes imports of technology, is produced by the State Planning Commission after widespread consultation with relevant industrial and ministerial bodies. There appear to be several bodies which can request that items of technology be included in the list of planned imports. Among these are the State Science and Technology Commission, the Chinese Academy of Sciences, the National Defense Science, Technology and Industry Commission, and the various industrial ministries such as the Ministry of the Electronics Industry (see figures 1 and 2). Planned imports must also be approved by the State Economic Commission, the Ministry of Finance, the Ministry of Foreign Economic Relations and Trade, and in some instances by the Bank of China, which controls foreign exchange. The Ministry of Foreign Economic Relations and Trade also contains a Technological Import and Export Department, established in 1979,

which drew up the regulations on technology import and seems to concern itself primarily with the commercial framework of technology imports.<sup>16</sup>

While the responsibilities of the industrial ministries are fairly clear, those of such bodies as the State Science and Technology Commission are less clear. In theory, the Chinese Academy of Sciences concentrates on basic research, overseeing the work of 117 scientific institutes, while applied research is done by research bodies under the industrial ministries. The State Science and Technology Commission is to focus on long-term policy, and on coordinating and reviewing the work of all basic and applied research organizations. The National Defense Science, Technology and Industry Commission, established in 1982, is to manage and coordinate research in the military sector (which includes electronics, space activities, aircraft, and ship-building) and see that research is relevant to the needs of factories producing military goods. The military research and development system is generally considered to have some of China's most advanced technology and most highly skilled workforce and to be a probable consumer of advanced foreign technology in various fields.<sup>17</sup>

The end result of the formal planning process is a list of "items" of technology to be imported, along with funds for their purchase. From 1985 through 1987 China plans to carry out 4,820 technical upgrading projects using imported technology and equipment costing \$14.2 billion in foreign exchange.<sup>18</sup>

The formal planning process is highly complex. Its theoretical rationality is vitiated in practice by lack of adequate information, lack of sufficient skilled administrators, insufficient information-processing capacity, and bureaucratic politics which mean that the final allocation of scarce goods like foreign exchange often reflects power, patronage and negotiating skills. Furthermore, the central planning mechanism, while perhaps adequate for estimating and allocating the production of such major commodities as cotton or basic industrial chemicals, has generally performed poorly in managing innovation, a process that is inherently not amenable to prediction. Even the technically much more sophisticated Soviet planning system has found it very difficult to do cost-benefit analyses of proposed projects.<sup>19</sup>

With its responsibilities for long-term national planning, the State Science and Technology Commission might seem the logical author of the definitive list of technology to be imported. It, however, is estimated to have a staff of only 200, and in its efforts to oversee the nation's research work focuses on a few very important projects, such as remote sensing systems or development of supercomputers, providing only generalized guidance for the lower-level institutes it supposedly oversees. Its plans are produced after preliminary national conferences to solicit expert opinion, extensive consultation with the State Planning Commission, internal ranking of projects, and final allocation of funds released by the Ministry of Finance.<sup>20</sup>

The complexities involved in the purchase of technology are demonstrated by one observer's attempts to describe the path for approving purchases of electronic goods:

At the head of the pyramid is the State Planning Commission, which liaises with the Ministry of the

Electronics Industry (MEI) on the one hand and the Ministry of Foreign Economic Relations and Trade (MOFERT) on the other. Through MOFERT the Commission has links with three import and export corporations: the China National Instruments Import and Export Corp. (INSTRIMPEX); the China National Machinery Import and Export Corp. (MACHIMPEX); and the China National Technical Import and Export Corp.

The MEI cooperates with the Administration of the Computer Industry (ACI) and the China Electronics Import and Export Corp., and through the latter two organizations with three computer industry cooperations in Beijing, Shanghai, and Guangzhou. . . .

An alternative route, according to one source, is to start at the bottom with the Galaxy Co., a Hong Kong-based firm which embraces everything to do with electronics. It would report back to the ACI, the specialized bureau under the MEI.<sup>21</sup>

The responsibilities of the various commissions, bureaus, and ministries, which all have some role in selecting technology, overlap, and the lines of authority and command are not clear. The recent and planned reforms of science and technology which stress economically useful research and call for a greatly increased role for contract research will further blur the distinctions between the Academy of Science's institutes and those of the industrial ministries. Furthermore, in a system where projects, including importing technology, require the approval of several distinct bodies responsible for planning, screening, licensing, funding and allocating foreign exchange, the potential for delay and unproductive boundary disputes is obvious.

### 3. SOLUTIONS TO TECHNOLOGY IMPORT PROBLEMS

#### a. Leading Groups

The problems are obvious to those attempting to make the system work, and the response has taken two distinct forms, leading groups and consulting companies. The central leadership has instituted several special working groups. In January 1983, the State Council set up a special "Leading Group for Science and Technology." Headed by Premier Zhao himself, it includes leading members from the various bodies discussed above. Its goals are to ensure unified leadership in making long-term plans for science and technology, including the technical transformation programs for various industries and to study technology policy and make decisions on the import and assimilation of important technical know-how.<sup>22</sup> At least in formal terms, this group is the final authority on technology transfer policy, which is reasonable considering the centrality of technology transfer. There are similar leading groups, intended to cut across bureaucratic boundaries, for such areas as the electronics industry, computers, and equipment development and acquisition, all key areas for modernization. Thus, the electronics leading group, created in September 1984, is directly subordinate to the State Council and is

intended to alleviate the problems of demarcation of authority encountered by the Ministry of the Electronics Industry in its efforts to coordinate electronics development.<sup>23</sup>

The formation of such special task forces demonstrates recognition of organizational problems and high-level determination to overcome bureaucratic higgling and obstructionism. At the same time, it represents a short-term, expedient response to a systemic problem, and in that sense is more a symptom than a solution. If the goal is the widespread technical modernization of thousands of enterprises throughout China, and if the existing administrative machinery is inadequate for its tasks of planning and coordinating the necessary import of technology, then adding yet another layer of "special groups" and "task forces," each with their own staff and communications links with existing offices, commissions, and bureaus, is not likely to solve the problem. There is, after all, a practical limit to the number of special groups that can operate effectively, as well as to the number of import projects any special group can speed through the bureaucratic network. The heart of the problem may well lie in the sheer number of projects, which is overwhelming any attempt by even the most dedicated and hard-working officials to coordinate them or to rationally decide priorities. Furthermore, the formation of such groups represents in organizational form the old "big push" or "campaign" style of work that has been practiced in China since the early 1950s, and which lies behind much of China's problems with unbalanced development. After all, it ought not to require the personal sponsorship of the nation's premier and highest-level political leaders to see that routine administrative work is carried out.

#### b. Consulting and Trading Companies

At the other end of the system, the past few years have seen the development (often as pilot projects or under official sponsorship) of many advising or consulting companies which offer ways to cut through red tape or circumvent tedious bureaucratic procedures. In many cases it seems that their leaders are offering personal connections or influence. One of the first such organizations, the China International Trust and Investment Cooperation, formed in 1979, has been active in promoting joint ventures. Among the more recent examples are the China New Technology Development Corporation, established in January 1985, intended to help develop new technology and products, and the Zhonghua International Technology Development Corp., founded in the spring of 1984. Among other activities, the latter plans to import sophisticated science, technology, production and management expertise, and to negotiate contracts between foreign and Chinese enterprises. It will also determine the technology and equipment needed from abroad, help bring in funds to import the equipment, and apply for import licenses. For a 5 percent commission it will help foreign firms find sites for new plants and study the best forms of cooperation in technology transfer.<sup>24</sup>

Similarly, Shanghai's Nanyang International Technology Company, formed by Jiaotong University in 1983, acts as agent to import equipment and technology for its associated factories, many of them in other cities than Shanghai. Jiaotong University faculty members act as technical advisors to speed the absorption of new technology. This company's activities have been possible only because of the special freedoms granted to Jiaotong University

in 1979. The existence of a network of loyal Jiaotong alumni both in China's central government and among successful overseas Chinese businessmen and scientists may well be a key element in its ability to function effectively. Politburo member Wang Zhen is head of the Jiaotong University Association, and Jiang Zemin, former Minister of the Electronics Industry and present Mayor of Shanghai, is an active member. Fellow-alumnus Wang An, President of the US firm Wang Laboratories Inc., has supported the university's computer department, whose expertise is in turn available to the Nanyang Company.<sup>25</sup> In this case, the effectiveness of the connections between alumni of an elite university for establishing a network of communications that cuts across existing administrative boundaries is evident. Presumably many of the other recently-formed consulting and trading companies hope to trade upon non-official networks of connections as well. Such networks are common and effective channels of communication in the business worlds of Hong Kong and Taiwan.

### c. Proposed Reforms in Foreign Trade

The conduct of foreign trade and technology import by increasingly specialized and diverse companies and enterprises is not only an evident trend; it has become an official goal of government policy. The plan for the wholesale reform of China's foreign trade structure, announced in September 1984 and intended to be implemented step-by-step during 1985, calls for a reduction in the role of the central government's administrative organs and the replacement of the existing centralized import-export corporations by more purely commercial companies which will act as agents. Such firms, like the ones described above, will be responsible for generating their own revenue, will be taxed, will compete with each other, and will prosper to the extent that they can render acceptable service to their Chinese and foreign clients. Government control is to be exercised more indirectly through such means as a regulatory framework of laws and detailed regulations, tariffs, bank credit, and a reduced but still extant State Plan. End-users will be free to decide which import agent company to deal with, and after listening to their agent's advice, will decide for themselves what technology to import. As part of China's overall economic reforms, direct allocation of capital by the central or provincial governments is to be replaced by allocation of funds by banks, which will charge interest on loans and allocate credit by making the sort of risk and cost-benefit analyses common to banks in the West.

While it would seem that this planned reform, if implemented, would shift much of the responsibility for the choice of technology to the end-user and to the bank, free trade is not intended. The central government will retain a significant role. According to the authoritative explanations of the then Minister of Foreign Economic Relations and Trade, foreign trade corporations "should go through prescribed procedures of examination and approval," will require official permission to engage in foreign trade at all, and should "come under the unified administration of the Ministry of Foreign Economic Relations and Trade, and undertake the import and export tasks set by the State Plan."<sup>26</sup>

Although the reforms as outlined are goals rather than detailed blueprints, and many questions remain to be resolved, a great many existing as well as newly-formed companies are publicly offering their services as agents and consultants in the proper choice of advanced technology. These include



such pillars of the establishment as the Bank of China, the central bank dealing in foreign exchange. In what can only be described as a hard-sell advertisement, the Bank offers complete services in international business, including advice to Chinese enterprises wishing to introduce technology from abroad. Claiming to have supported tens of thousands of technological transformation projects since 1973, the Bank offers its experience and data, as well as access to the state's "relatively large amount of foreign exchange surplus," thus making an offer that many factory managers should find hard to refuse.<sup>27</sup>

#### d. Information and Choice By End-Users

Giving end-users responsibility for selection of technology ought to result in choices that are appropriate to their particular circumstances, but such choices depend on information on what sort of technology is available. While the central ministries and their import-export corporations presumably have technically competent staffs and libraries and files of foreign technical publications, such resources cannot be duplicated in every factory or even in every city (which is an argument for centralization). The information problem for end-users is exacerbated by Chinese factories' shortage of the engineers and technicians needed to evaluate information and make technically informed choices (assuming that it is engineers who make the choices). In the past, technically unqualified factory managers frequently selected inappropriate foreign technology or equipment, often insisting on the newest, biggest, and most expensive items, or tried to save money by refusing to pay for training or spare parts. A major element in the proposed reforms of the industrial system is replacing older, unqualified managers with better educated and professionally competent managers, and giving authority in the factories to technically trained professionals at the expense of Communist Party cadres, who are expected to restrict their activities to general policy oversight and boosting worker morale. Technically competent management is one of the many prerequisites for successful implementation of the new technology import program.

Some large factories include technical information offices with small staffs whose primary duty is to survey foreign scientific and technical literature. Although they have a potentially critical role in the successful transfer of technology, it appears that these offices have not been able to realize that potential. To find personnel with the linguistic and technical skills needed is difficult, and such offices have often been relegated to inferior status, as a result of their intellectual and therefore politically suspect staff, their perceived lack of relevance to the immediate tasks of production, and, until recently, the overall lack of interest in technical information or innovation.<sup>28</sup> Strengthening such offices and establishing them where they do not exist ought to substantially improve the transfer of technology to Chinese factories.

One solution to the information problem is to locate expertise on foreign technology and potential suppliers in the trading companies and agents. But they, too, will be affected by the shortage of skilled personnel and by problems with the flow of information through the system that, however imperfectly, links Chinese consumers with foreign suppliers of technology. While problems with information flow are common to all commercial or research



and development systems, they are exacerbated by China's size, shortage of skilled personnel of all types, and the legacy of a Soviet-style compartmentalized administrative and industrial structure. Successful implementation of the proposed, relatively decentralized system will require major improvements in China's technical information dissemination system. The problem is not so much sheer lack of information as it is one of designing a system to get the data to those who need it. This is a field in which Chinese graduates of the various foreign-taught management schools, such as the US program at Dalian, may prove very useful, as it is precisely the sort of issue that foreign management schools deal with, and a field hitherto ignored in China.

Well aware of the general problem of blocked and restricted information flow, Chinese officials have been making efforts to increase the availability of technical information through specialized newspapers and journals and through periodic "technology fairs." Technology developed in China can now be sold or leased by its originator, a change of policy from the previous treatment of technology and knowledge as a free public good. This new policy is explicitly intended to promote the dissemination of technical information. The new Chinese patent system intended both to promote the internal flow of information and to encourage foreign firms to transfer technology to China is part of the same policy. Many Chinese journals are devoted entirely to news of foreign scientific and technical developments. Their articles are brief and not very detailed, but presumably permit Chinese technical specialists to keep up with general developments in their fields. There are also some Chinese-language editions of foreign scientific and technical publications such as Scientific American, Computerworld, Instruments, Computers and Control Systems for Industry, and International Industrial Report. The motivation for publishing such issues is the foreign publisher's hope to profit by selling advertising to foreign companies hoping to do business in China. The fact that only 10 of the 27 magazines extant in late 1981 were still publishing in January 1984 might indicate that such advertisements have not proven a very effective means of selling to Chinese consumers.<sup>29</sup>

One solution to the problem of choice is to continue using the first foreign supplier a factory has dealt with, if it has dealt with any. This practice appears to be extremely common, and advice to foreign corporations hoping to sell to China often includes making great efforts (including accepting little or no profit) to make an initial sale because of the likelihood of later and often larger and more profitable sales. In the same way, many joint-ventures with foreign firms stipulate that the foreign partner is to be responsible for keeping up with current advances in world technology and introducing them to the joint venture company. That Chinese enterprises are so often willing to, in effect, grant a foreign company a monopoly on supplies to them indicates the difficulties they apparently find with selection of appropriate technology and reliable suppliers.

In general, to the extent that the present Chinese attempts to improve the flow of data on domestic scientific and technical advances succeed, information on foreign technology should also be more widely disseminated. The introduction of some elements of the market (as opposed to central allocation) into China's economy and industrial structure will require the substantial improvement of the technical and commercial information processing and distribution systems on which all markets depend for their successful operation.

#### e. Consequences of Reforms

To the extent that the proposed economic reforms and associated foreign trade reforms are effected, technology transfer should benefit. By devolving the choice of detailed, specific items of technology to their end-user, not only is the selection of more appropriate technology more likely, but the delays and unpredictable outcomes of the centralized planning and allocation system should be eliminated. Central planners and administrators should be better able to devote themselves to long-range planning and broad policy decisions. Since imports must be paid for, and foreign exchange will remain limited, a more critical role in the choice of technology will fall to the banking system. Whether the bankers will be better able to decide which items of technology are most needed and appropriate than the central planners have been remains to be seen (much will depend on the adequacy and reliability of the numbers used to make the decision), but to the extent that approval can be made within one organization rather than half a dozen, the efficiency of the system should be improved. However, for the banking system to be able to perform its function of allocating credit in the most rational manner, a fairly comprehensive price reform must be made, and that may well require many years.

All Chinese leaders are well aware of the problems caused by the present price structure, which they describe as "irrational," and thorough reform of the price structure is a major goal of economic reform. How this is to be done is not yet clear and progress so far has been slow and cautious, with prices for vegetables and some minor handicraft goods and services being permitted to vary within set limits. As the reforms take hold, the basic issues and problems are liable to shift from those of central bureaucratic organization and procedures to those of foreign currency allocation, terms of credit, exchange rates, and the import licensing and control framework. In other words, to the extent that foreign technology is treated as a commodity, the issues involved in its import will become general economic and foreign trade issues. They will reflect the basic fact that the potential demand for technology and equipment to renovate thousands of factories far outweighs China's ability to meet it by purchasing everything desired or needed. These economic realities mean that even if the import process worked with perfect efficiency, and if foreign countries were willing to sell China any technology it desired, it would still be necessary to limit and control purchases of technology, and hence to institute policies setting priorities and guiding the allocation of funds for technology.

#### 4. POLICY CHOICES

##### a. Modes of Transfer

Even though committed both to the large-scale import of technology and to dealing with foreign corporations which control industrial technology, Chinese leaders face a further series of decisions about which modes of technology transfer they wish to encourage or permit. Most technology is the proprietary information of private corporations, and its transfer is, among other things, a commercial transaction. Such transactions can take many forms, each with its own benefits and costs. The transactions can be arrayed along a continuum of intensity of interaction and duration of relationship. The

simplest form is a one-time sale, as of a patent or a production license, while the most complex would be full ownership or a major equity share by the firm providing the technology. In the latter case, the relationship would be permanent and the influence of the technology donor would extend to all areas of the recipient's operations, including such areas as personnel policies, production management, and quality control. The most effective mechanisms of technology transfer are those that permit long-term relationships and extensive consulting and troubleshooting.<sup>30</sup> One student of the process sums it up by saying

The transfer of new technology occurs largely through the verbal communication and interaction of people. . . ." "the most important single resource to effect technological change is trained scientists and engineers.<sup>31</sup>

The choice of a mode of transfer in any particular case depends on two major variables. The first is the gap between the skills of donor and recipient. The smaller the gap, the easier the transfer and the more likely it is to take the relatively simple forms of sale of patents, licensing of single processes or products, or even unauthorized reverse engineering. (Reverse engineering, though superficially no more than simple 'copying,' turns out in practice to require skills approaching those of the original producer.) The wider the gap in skills, the greater the need for long-term ties with extensive training and consultation. The second major variable is complexity and degree of standardization of the processes. The more advanced the technology, the greater the need for training and on-going consultation, if only because most new products, especially in high technology, require further modification and "debugging" and those who purchase them, regardless of their skills, need to keep in close contact with the producer, both to report problems and to be informed of modifications and improvements.

Each mode of transfer has a direct and an indirect cost. Superficially, licensing, purchase of patents, and other forms of one-time transactions are cheapest, especially if they involve technology that the parent company no longer considers state-of-the-art or equivalent to that of its major competitors. However, if the recipient turns out to be unable to use the license or patent, or requires additional guidance as a separate package, the initial low cost may prove illusory. Many Chinese writers have commented on the tendency of technically unqualified managers or financial authorities to try to save money by selecting the simplest forms of transfer, or by refusing to authorize payment for training or consulting. The more extensive the interaction, the greater the direct transfer costs (for training, translation, services of consultants, travel, etc.), but the greater the likelihood of realizing benefits from the technology. Where the foreign firm either owns or has an equity share in the recipient firm, it has a strong incentive to see to it that the technology is mastered. The same argument applies to royalty arrangements.<sup>32</sup>

#### b. Joint Ventures

Chinese authorities, torn between unfavorable results from whole-plant purchases (which, while effective at increasing production of the plant's

commodity, did not appreciably increase Chinese technical skills) and simple, one-time purchases and the strong political pressure against permitting foreign ownership or direct foreign employment of Chinese workers, have opted for the joint equity venture as the technology transfer mode of choice. In such ventures both a Chinese and a foreign partner contribute capital, each provides what it has the advantage in, (usually technology and access to world markets from the foreign partner and labor and familiarity with the Chinese industrial and administrative environment from the Chinese partner), and, the partners split management responsibilities and profits.

The problem with joint ventures has been finding foreign firms willing to accept such arrangements. The foreign firm is expected to contribute its capital to a venture it does not wholly control in a country with a legal and commercial system it regards as inadequate to protect its investment. While the Chinese side wants the joint venture to introduce technology and products that can be exported to earn foreign exchange, the foreign corporation usually desires access to the domestic Chinese market and profits it can repatriate, and has no desire to see its international sales threatened by Chinese products manufactured with its technology. To gain access to foreign technology through this form, Chinese authorities have had to institute substantial reforms in the legal, tax, and foreign exchange control systems, and only in 1984 did any substantial number of major foreign firms institute joint manufacturing ventures.<sup>33</sup>

#### c. Leasing and Commercial Sophistication

There has been a recent surge of Chinese interest in leasing foreign equipment, as well as formation of several Chinese and Sino-foreign leasing companies. Leasing is becoming an increasingly important mode of technology transfer, and the two top leasing companies tripled their business in 1984.<sup>34</sup> Leasing and the purchase of bankrupt foreign factories are examples of increasing Chinese commercial sophistication. Since 1978, many Chinese cadres responsible for technology transfer and foreign trade have learned a good deal about international commerce and some of the opportunities it affords (perhaps with the help of Hong Kong partners). They have recently made some deals, such as the purchase of a modern steel mill from a financially distressed Belgian corporation for only one-seventh of what it had cost to build the mill a few years earlier, that have earned the admiration of Western capitalists.<sup>35</sup> The increasing willingness of Chinese purchasers to pay for training and consulting services also demonstrates greater commercial sophistication. To what extent such effective purchasing methods will be used for or by the Chinese end-users who are to have a greater voice in technology selection remains to be seen.

#### d. Further Policy Choices

In general terms, the package of economic reforms proposed over the past few years is quite favorable to technology transfer. (These are, in brief: "opening to the outside world;" loosening central regulation; management by middle-aged technicians rather than elderly CCP functionaries; limited but increased use of market mechanisms; increased circulation of commodities, personnel and information; and major reform of the price system, on which all else depends.) The more fully such reforms are actually effected, the more

effective the transfer of technology both from foreign countries to China and from more to less advanced units and regions within China.

But, within this general framework, on which we can assume there is a fair degree of consensus within the national leadership, there are still many areas in which further decisions must be made. These decisions are not easy because in many cases they involve questions of degree (how much decentralization, how far to go in accomodating foreign corporations), as well as issues in which competing national interests must be balanced. The major issues are:

- °the degree of decentralization,
- °the form of "indirect" central controls on the economy,
- °balancing long-term and short-term benefits,
- °how far to go to win the confidence of foreign corporations,
- °which industries or fields get priority,
- °what level of technology for which to aim, and
- °what incentives will motivate managers to make investments in technology with a long-term payoff which the central planners consider necessary?

In brief, the arguments for decentralization are the evident ineffectiveness and costs of the centralized planning and purchasing system, as well as the inordinate delays it imposes. The arguments for more centralization feature the theoretical advantages of planning and allocation of resources to projects with the greatest national benefit, as well as the evident waste and duplication that has taken place when central controls have been relaxed. The term of disapproval for unplanned activities is "blind" as in "blind development." Chinese regional authorities, who have been the major beneficiaries of administrative decentralization, have shown a marked preference for import projects that offer an immediate cash payoff, for example, assembly lines for televisions, tape recorders, or other consumer goods, such as cigarettes, whose high fixed price promises good profits. Regional authorities have also shown a disinclination to invest in projects such as energy or transportation which have a long-term payoff and which the price structure makes distinctly unattractive as investments.<sup>36</sup> Since it is precisely energy and transportation that are the major bottlenecks in the Chinese economy, they should have a high priority for imported technology. More efficient boilers and engines will make a far greater contribution to quadrupling China's production by 2000 than will tape recorders or cigarettes, and there is no shortage of people willing to make this point within the Chinese leadership.

Since China has no experience with directing the national economy through "indirect" controls or levers such as tax and interest rates, there is room for considerable disagreement and experimentation over just how to achieve this desired goal. If an experiment does not turn out well, there is always pressure to return to strict centralized controls.

The factors promoting choice of short-term or of long-term benefits in particular cases are illustrated in the fields of aircraft, military equipment, and computers. For example, while it is clearly in China's long-term interest to develop its aviation industry, the effect of recent decisions in this field has been to push for short-term benefits by importing foreign civil airliners in large numbers. Little has been heard in recent years about the Chinese-developed jet transport, the YUN-10, a four-engine plane whose design was inspired by the Boeing-707. The April 1985 agreement for coproduction of the McDonnell-Douglas-82 at the Shanghai Aircraft Plant (which developed the prototype YUN-10) indicates that short- and medium-term concerns have won here.<sup>36</sup>

In the military field, however, decisions have gone the other way. Although China faces a clear military threat from the Soviet Union, and West European arms manufacturers have been willing and eager to sell weapons and technology to China at least since 1976, China has purchased remarkably little in the way of weaponry. The decisions here appear to have been to stress the long-term advantages of enhancing China's ability to develop and produce weapons on its own and to assimilate selected bits of foreign military technology without close relations with foreign suppliers. Chinese decisions on both production of civil airliners and military hardware have been reasonable, but there would have been equally good reasons for pursuing another course.

The issues of protecting and nurturing domestic industry (a long-term goal) has been raised in the computer field. In an impressive achievement, China can produce its own computers. But, in part because of deficiencies in mass production of such precision devices, Chinese-made computers are more expensive, less reliable, and less standardized than foreign ones. Consequently, imports of computers have grown manyfold since 1980. Numerous contracts have been signed for production in China of foreign microcomputers, and it now appears that except for research prototypes or a few models of supercomputers such as the "Galaxy," which are subject to foreign export controls, China's computer industry will be devoted to the assembly of various foreign models. This will enhance manufacturing technology and quality control, but the long-term prospects for an indigenous computer industry do not seem promising. The factors that seem to have shifted the balance away from protecting the domestic industry are the high production volume and standardization offered by foreign production technology. High volume and standardization are in turn prerequisites for the widespread adoption of computers in Chinese offices and the development of a Chinese software industry, goals that have taken precedence over growth of the domestic computer industry.<sup>38</sup>

As these examples demonstrate, the balance of options differs from sector to sector. Strict accuracy thus would demand specification of what sector is meant when discussing technology transfer policy. It is also possible to readjust policy within any single sector without affecting the overall policy orientation favoring technology transfer. In the near future, debate in China is likely to focus on questions of degree and of balancing competing interests. As such issues become more salient, minor changes of policy, perhaps on a sector-by-sector basis, are likely, and low-level debate and turbulence in technology policy seem likely. Changes in the degree of centralization or of willingness to purchase such finished goods as aircraft

or telephone exchanges can be expected both as leaders respond to immediate problems, such as loss of control over foreign exchange spending or the withdrawal of foreign participation in a long-delayed project, or as those Chinese groups disadvantaged by a particular policy succeed in forming coalitions with other interests and bringing pressure to bear.

e. Grounds for Policy Decisions

Different actors (industrial ministries; regional authorities; provincial factories; producers of basic, heavy industrial goods) within the Chinese system have different goals, and these goals can be identified. Thus, it has been argued that central planners and officials of the industrial ministries tend to prefer the introduction of basic technology which will have an effect in the long-term of a decade or so, while factory managers are more concerned with immediate payoffs or solutions to their current problems. If so, then one consequence of devolution of decisionmaking to end-users would be an increase in the import of intermediate-level or already proven, even if somewhat outdated, technology. If the military goods industries are, as sometimes asserted, interested in preserving their own relative autonomy and if they possess a high level (by Chinese standards) of technical skills, then they would be more likely to prefer acquiring technology through such fairly simple, arms-length methods as purchase of patents, license of single processes, or reverse engineering of samples.

It is also claimed that the desire for innovation (including absorbing foreign technology) is often strongest in smaller, relatively more marginal industries which do not dominate their markets.<sup>39</sup> Innovation is always a risk and a threat to established procedures and organizational arrangements, and organizations that are not threatened seldom go in for risk-taking. In the Chinese case, some industries, such as electronics and shipbuilding, as well as many light industrial producers of consumer goods, have been more active in acquiring foreign technology than such central and politically favored industries as electric power generation, the railroad system, and the military industries. While the absorption of technology by the former industries is of course a net gain, the priorities for China's overall development are energy and transport. Hence, it would appear that the task for the immediate future is devising incentives to encourage powerful and favored industries to take the risks inherent in absorbing technology. Competition and the threat of bankruptcy may inspire the managers of provincial television or washing machine factories to seek foreign partners, but have little effect on the railroads or electric power industry. Price reform is likely to be at least part of the package devised for this purpose, by increasing the costs of raw materials and holding out the promise of increased profits from technical advances.

5. IMPLICATIONS

a. Implications for China

The success of technology transfer on a broad scale is inextricably connected with the economic reform program. The success of one depends on the success of the other.



With the decisions in the first half of 1985, on at least the outlines of a reformed economic and foreign trade structure, the issues in technology transfer should shift away from national-level policy--such as patent law and regulations on joint ventures--to matters of distribution and benefit to various subsectors of Chinese industry (such as computer manufacturers or computer users) while disputes and turmoil continue within the general framework erected between 1980 and 1985.

Barring a total change in government and reversion to the isolation and xenophobia of the Cultural Revolution period, the technology transfer program has developed such momentum that it will not be called off no matter who succeeds Deng Xiaoping. However, there is room for considerable modification of the direction and content of the program. It might turn away from the production of consumer goods towards heavy industry or it might favor one supplying nation over another as China's foreign relations change.

b. Implications for China's Foreign Relations

The program depends on the willingness of foreign companies to sell technology to China. However, there is at least a potential conflict between foreign corporations interested in selling goods and services to China rather than in modernizing Chinese industry, and the Chinese, who are basically making concessions to foreign corporations only to get access to technology with which to make China independent of foreign firms. Relations in which each side thinks it is doing the other a favor while cooperating on so risky a task as technology transfer have the potential for major deterioration once the initial euphoria wears off.

As foreign corporations become more closely involved in China's economy, their relations with Chinese business partners and the perceived success of their attempts to transfer technology will inevitably influence China's relations with the governments of the companies' home countries. In the United States, major corporations desiring to sell their products and services to China have been a source of pressure on the US Government to liberalize or lift its restrictions on the sale of technology to China, and what the Chinese consider as the unreasonable reluctance of Japanese companies to transfer technology to China have been an irritant to Sino-Japanese relations.

Estimates of the success of technology transfer to China must speak of specific industries or sectors, for results will differ considerably. While China's size and the very poor and backward nature of large regions in the interior mean that the sort of technical information and export-led growth that characterized South Korea or Taiwan in the 1960s and 1970s is not a possibility, it is quite possible for Chinese products in some sectors to reach sufficiently high standards and low prices to threaten other nations' export markets in those fields. The substantial growth in China's total foreign trade, fueled by growingly sophisticated exports, has been a major factor in convincing such basically hostile or fearful nations as Indonesia that they must come to some sort of terms with China.

## 6. CONCLUSIONS

The series of economic and foreign trade policies adopted by China since 1980 have been favorable to promoting the transfer of technology to China. Their adoption also demonstrates the Chinese leaders' determination to go beyond rhetoric and make major changes in such things as the foreign trade structure in order to promote technology transfer. Policy on technology transfer, to the limited extent that it can be distinguished from general economic policy, is now formally made by a State Council "special leading group," headed by Premier Zhao Ziyang. But the scope and diversity of technology required to modernize thousands of obsolete and inefficient Chinese factories continues to make centralized planning and control ineffective in any but the most general sense. The logic of the situation has progressively pushed a policy of decentralization and devolution of decisionmaking to lower administrative levels, and the need for effective assimilation of advanced technology to achieve the Four Modernizations has been an important driving force in the general economic reform program.

There are two major impediments to effective transfer of technology. The first consists of problems of assimilating technology within specific factories. The problems here, while serious, are basically ignorance, lack of familiarity with the requirements of the technology, and attempts to introduce technology into an inappropriate context, problems which can be resolved over time by better education, training, and experience. The second set of impediments are presented by the Chinese economic and industrial system itself, such as overly rigid centralized planning and control, overemphasis on production and underemphasis on exchange, lack of incentives for innovation, excessive compartmentalization, and an irrational price system. These can only be resolved by systemic change. Change has begun and its success depends on the political skills of these Chinese leaders attempting to carry it out. The more fully the economic reforms are put into practice, the more likely technology transfer is to succeed.

The broad rubric of "technology transfer" encompasses many differences in goals and achievements among various sectors of Chinese industry. Although there is apparently general consensus on the overall policies promoting technology transfer, many detailed decisions have yet to be made. These decisions will affect the interests of industries and sectors having somewhat distinct and sometimes contradictory technology transfer goals. Discussion, debate and reversals of policy at the lower, working levels are likely to continue. The political economy of technology transfer within China is a topic that has been little explored, but as the flow of technology into China expands and accelerates, it should receive further attention.

## NOTES

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